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AUTHOR Murphy, Gary T.
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ABSTRACT

Two instruments and instructional activities were pilot tested to determine if they could be used in a later evaluation study of a Domain of Cognition model, developed by Robert J. Stahl as an alternative to Bloom's Taxonomy. The model, intended to help educators more effectively plan for, implement, monitor, and evaluate instruction, was proposed as being a representation of a sequence of expected behavioral outcomes that may result from instruction. After instruction has taken place and after students have been given the time to make use of different types of information, it was contended that the sequence of outcome behaviors should occur as depicted in the Domain of Cognition. Two fifth and sixth grade classes participated in the study. Major findings include the following. The instructional activities and the immediate and delayed posttests were clearly understood by the students. The internal consistency for both posttests was high. The mean score performance was not in a descending order on either the immediate or the delayed posttest. Based upon these results, the decision was made to conduct the larger study. Appendices contain the tests and the instructional activities. (RM)

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A Report of the Preliminary Research Findings on the Domain of Cognition:

A Taxonomy of Instructional Outcomes

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Gary T. Murphy

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Gary T. Murphy
Miami Public Schools
Drawer H
Miami, AZ 85539

Robert J. Stahl
Arizona State University
Department of Secondary Education
Tempe, AZ 85287

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Introduction

The Domain of Cognition is a model which has been proposed by its author, Robert J. Stahl, as a model which shows a sequence of instructional outcome behaviors which are expected to occur as a result of instruction. This model, shown in Figure 1, has been described by Stahl (1983) as a sequence of levels so that as students progress through each level, the learned information becomes increasingly integrated with other information the students may already have. As a result of the increased integration, Stahl contents that students will tend to utilize acquired guidelines, principles and rules more habitually than when they were first practiced and put to use.

Each of the levels along with any sublevels of the Domain of Cognition are described below.

Preparation

Preparation level behavior indicates that students are mentally ready to receive information about to be presented. At this level students may show such typical Preparation level behaviors as looking at the teacher, having desks cleared and pencils ready, reading through notes which pertain to today's lesson, etc. Preparation level behaviors are displayed before the actual presentation of new information begins.

Reception

Reception level behavior indicates that students are receiving or have just received new information. Students give evidence of remembering information in nearly the same way as it was presented to him earlier in the same lesson. There are three sublevels within Reception, each of which describes a different type of Reception level behavior. The first sublevel is Literation. This behavior is characterized by students

reporting information which is immediately before them. This type of behavior requires no memory or recall. It is only indicative of what the student "sees" before him/her. The second sublevel is Recognition. This behavior requires students to indicate whether information is similar to or different from other information given earlier in the same lesson. This may be indicated through matching, multiple choice and true-false types of questions. The third sublevel, Recollection, includes behaviors which show that students can supply near word-for-word information when asked for. This may take the form of providing information on fill-in-the-blank and short answer types of tests. With all three sublevels the behaviors show verbatim or near verbatim reporting or remembering of information as it was given in that same lesson.

Transformation

Transformation level behavior reveals that students have made personal sense of information just received and/or have applied the received information in some way. There are two sublevels within Transformation. The first, Personalization, includes behaviors which may take the form of paraphrasing information - putting something into their own words. This type of behavior gives evidence of how the information 'makes sense to' students. The second sublevel, Adaptation, includes behaviors in which the students put applicable types of information (e.g., rules, principles, concepts, etc.) to use in some way(s). These types of application behaviors take place during the same lesson in which the information was presented.

The above levels and sublevels described behaviors which took place on the same day in which information was presented. The following levels

and sublevels describe behaviors which may take place during the next lesson (very often 23 hours later) and/or following lessons.

Retention

Retention level behavior shows that students can remember information which was presented to them and possibly applied by them. Behavior on this level takes two forms, each of which can be described in terms of sublevels. The first sublevel, Recognition, requires students to verify whether or not information currently before them is similar to or different from information encountered 23 or more hours earlier. This can be verified through true-false, matching or multiple choice exercises. Recollection is the second sublevel. The behavior shown by students on this sublevel requires them to provide needed information as they remember it. Short answer and fill-in-the-blank types of exercises are ways of verifying Recollection behavior. Both sublevels represent the same behavioral operations as the two similarly named sublevels in the Reception level. The difference lies in when the information is dealt with and what types of memory system is being used. At the Reception level information is dealt with on the same day in which it was first encountered and incorporates primarily 'short-term' and 'working' memories. Retention level behavior is displayed 23 or more hours after information was first encountered and incorporates 'long-term' memory.

Cueplication

At the Cueplication level students behave in ways which give indication that they can put information to use when specifically instructed to do so. At this level, students utilize principles, rules, guidelines, etc. because they were directed by some external source to use a specific

1.00 PREPARATION

"OBSERVATION" (input of new information)

2.00 RECEPTION

- 2.10 Literation
- 2.20 Recognition
- 2.30 Recollection

3.00 TRANSFORMATION

- 3.10 Personalization
- 3.20 Adaptation

"INFORMATION ACQUISITION" (encoding and storage of information into Long Term Storage)

4.00 RETENTION

- 4.10 Recognition
- 4.20 Recollection

5.00 CUEPLICATION

- 5.10 Replication
- 5.20 Variation

6.00 TRANSFERSION

- 6.10 Replication
- 6.20 Variation

7.00 AUTOMIZATION

8.00 SCHEMATION

- 8.10 Characteration
- 8.20 Organization

Figure 1 An Outline of the Domain of Cognition (Stahl, 1983)

type of information. There are two sublevels at the Cueplication level. The first sublevel, Replication, describes behavior in situations which are similar to those where the students first applied them. Variation sublevel behavior is demonstrated when students make use of information to arrive at answers or solutions in situations which are different from those where the students first applied them.

Transfersion

Transfersion level behaviors indicate that students will put information to use without being directly instructed to use particular information in that situation. Students are able to "decipher" the context of the situation to determine what type of information is to be made use of, and then apply this information to arrive at a solution to a problem. Replication sublevel behavior shows that students will apply information to solve problems in situations like those where it was first applied. Variation sublevel behavior shows that students will apply information to solve problems in situations unlike those where it was first applied. Students at both sublevels are not directly cued to apply information but are able to 'read the cues' embedded in the situation to which information can be applied.

Automization

Behaviors or test situations which show that students apply principles, rules, guidelines, etc. in an automatic manner is evidence of this level. For the student to perform at this level, principles, rules and guidelines must have been practiced and put to use so often that their application is now automatic. Students who achieve this level of behavior have become so accustomed to responding in certain ways that

they no longer consciously have to think about their behavior. There are no sublevels at this level.

Schemation

Schemation level behavior reveals how the students view the world and how they explain the way 'things are'. Behaviors on this level are a result of habitual application of information in different types of situations. Students may state personal beliefs about something with these beliefs being held as true by them. Students may make a judgment or decision and then justify or explain their choice on the basis information they believe to be true. Students may also assign value to different types of information and explain how they are related to issues or situations they are familiar with. Students may reveal typical ways of behaving in respect to real or hypothetical situations. The sublevels at this level are Characteration and Organization. Characteration can be defined as behaviors which indicate what the student believes about something. These indicators may take the form of criteria, descriptions, explanations, etc. These behaviors also reveal what is typical of the students as demonstrated in school situations where such behaviors are called for. Organization sublevel behavior is characterized by students demonstrating how beliefs, perceptions, etc. are prioritized in comparison with other beliefs, perceptions, etc. Behaviors at the Schemation level give evidence of what and how information is integrated into ones cognitive-belief system.

History, Purpose and Intended Uses of the Domain of Cognition

As a taxonomic model and a quasi-learning hierarchy, the Domain of

Cognition has been periodically altered and revised since its first formal presentation at the Annual Convention of the National Council for the Social Studies in Houston in 1978. However, prior to 1978 and while teaching undergraduate students at the University of Florida (from 1974 to 1975) and Mississippi University for Women (1975 to 1978) Stahl tried to make use of and implement Bloom's Taxonomy. Finding that his students experienced difficulty with Bloom's Taxonomy, attempts made initially to refine or modify it were met with limited success. No attempt was made between 1975 and 1978 to develop an entirely new system.

Working papers were begun on an alternative to Bloom's Taxonomy in 1978. The content of these working papers incorporated findings from psychological and educational research dealing with learning, thinking and memory. With continued support and encouragement from colleagues at Arizona State University's Department of Secondary Education towards development of an entirely unique model which would incorporate these findings, the presentation of an alternative model at the above mentioned convention was given.

From 1978 to Spring, 1981 Stahl continued with refinements which were based on input from scholars from different areas of the country. The model as presented in this project is the final form of that effort.

The purpose for developing such a model was to help educators more effectively plan for, implement, monitor and evaluate instruction. As teachers become more effective in these four areas greater efficiency should result as should higher levels of outcome behaviors on the part of students (Stahl, 1981a).

Stahl (1982b,c) has asserted that the Domain of Cognition can be used in the following ways:

A. As a taxonomy which describes separate and distinct types of thinking which individuals may and can do.

B. As a taxonomic model which sequences these types of thinking.

C. As a hierarchy-like model which shows the prerequisite relationships among different types of thinking, learning and learned outcomes.

D. As taxonomic model which describes the order of learned outcomes which may and can occur as a result of instruction.

E. As taxonomy which describes the order of learned outcomes which may and can occur as a result of instruction.

While Stahl has written that the Domain of Cognition can be used for all of these, the focus of this researcher's investigation was D and E above.

Purpose of this Project

The purpose of this project was to pilot test two instruments as well as to determine how feasible a number of instructional activities were to help provide a variety in experiential background for testing situations. The information gathered was then used to help guide a larger research effort conducted by the researcher (i.e., dissertation for Ed.D., Arizona State University). The model under investigation, the Domain of Cognition (Stahl, 1979, 1981), has been proposed as being a representation of a sequence of expected behavioral outcomes that may result from instruction. After instruction has taken place and after students have been given the time to make use of different types of information, Stahl has contended that the sequence of outcome behaviors should occur as depicted in the Domain of Cognition. This project was

conducted as an initial investigation into whether or not this sequence actually occurs.

If this sequence is shown to actually occur, it has promise in helping to fulfill the needs educators may have in planning, monitoring and evaluating instruction.

This researcher sought to investigate how upper elementary age students having a varied experiential background performed on immediate and delayed posttests. The order of the outcome behaviors were compared to the order of the following sublevels within the Domain of Cognition: Immediate Posttest - Reception: Recognition, Reception: Recollection, Transformation: Personalization, Transformation: Adaptation; Delayed Posttest - Retention: Recognition, Retention: Recollection, Cueplication: Replication, Transfersion: Replication. Proper order was designated to have occurred when the group mean score performance resulted in a descending order.

Research Questions

Research Question 1: Are the instructional activities which were developed to provide a variety in experiential background clearly understood by subjects who would use them?

Research Question 2: Are the immediate posttest and the delayed posttests clearly understood by subjects who would take them?

Research Question 3: Is the internal consistency of the immediate posttest and the delayed posttest sufficiently high to warrant their use on a larger scale?

Research Question 4: Is the mean outcome performance on the subsections of each of the posttests in descending order?

Procedures

This section of the project is divided into six parts. These parts are: Population and Sample, Design of the Study, Event Identification, Materials Development, Instrumentation, Data Collection, Reduction and Analysis. A description of each part follows.

Population and Sample

The sample for Pilot Study 1 was two 5th and two 6th grade classes selected from seven 5th and seven 6th grade classes from the Globe, Arizona Unified School District during the Spring semester, 1983. The sample for Pilot Study 2 was one 5th and one 6th grade class from the same school district (excluding the four classes which were used in Pilot Study 1). Subjects from Globe, Arizona were chosen for both of the pilot studies because of its close proximity to Miami, Arizona (where the main research was to be conducted) and secondly, because both Globe, Arizona and Miami, Arizona have similar populations in respect to socio-economic status, types of employment, and racial composition.

Design of the Study

The design of both pilot studies had some of the characteristics of repeated measures designs (Ferguson, 1976) with the distinction being that the data analysis sought to interpret the results in light of the model being studied as opposed to concerns with differences between individuals or groups. Seven different instructional activities (also referred to in this project as "a variety in experiential background") were given randomly to sixty-six subjects in the first pilot study, and sixteen instructional activities were given to randomly to forty-six

subjects in the second pilot study. Since the nature of the research in this project was not to test the effects of treatments, no experimental design which focused upon treatment effects was used. The purpose of this project was to determine whether or not the sequence of outcome behaviors matched the sequence of levels in the Domain of Cognition under conditions which simulate a typical classroom instructional situation (both on the day of instruction and approximately 23 hours later).

As is the case in most instructional testing situations, students come with a variety of experiential background concerning a particular content area. According to Stahl (1981a), this variety of experiential background is likely to produce a descending order of scores consistent with the outcome behaviors as included in the Domain of Cognition when used a model of instructional outcomes.

Four repeated measurements were taken of the subjects immediately following their varied instructional activities (immediate posttest). Four additional repeated measurements of the same subjects were taken approximately 23 hours after they completed the immediate posttest (delayed posttest).

Event Identification

The events of this project and sequence were developed in cooperation with Robert J. Stahl. These events were as follows.

1. Study started.
2. Specific behavioral objectives written for each sublevel of the Domain of Cognition that was within the scope of this project.
3. Reasonableness of the specific objectives checked with experienced teachers with corrections made if needed.

4. "Variety-in-experiential-background" material developed.

5. Reasonableness of the "variety-in-experiential-background" material checked with experienced teachers with corrections made if needed.

6. Immediate and delayed posttest developed.

7. Reasonableness of the immediate and delayed posttests checked with experienced teachers with corrections made if needed.

8. Readability determined on immediate and delayed posttests, "variety-in-experiential-background' material with corrections made if needed.

9. Approval obtained from appropriate Globe School District personnel to conduct project.

10. Project conducted.

11. Data collected from all subjects.

12. Data appropriately prepared for data analysis.

13. Data analyzed using appropriate statistical procedures.

14. Project completed.

Materials Development

Development of the "variety-in-experiential-background" material was consistent with the four sublevels of the Domain of Cognition of Reception: Recognition, Reception: Recollection, Transformation: Personalization and Transformation: Adaptation as each applied to information concerning pendulums, and were developed in cooperation with Robert J. Stahl. Based upon an informal survey of teachers, information on pendulums was considered to be something that subjects were unfamiliar with but at the same time it was considered simple enough for them to understand.

The readability of the variety in experiential background was considered to be important in respect to eliminating it as an intervening variable. If the readability of the material was found to be at the independent reading level (easy) or at the instructional reading level (somewhat easy) for most of the subjects, then this variable was considered to accounted for. The findings for the readability study on the pendulum material was found to be at the 5.0 grade level. For the rest of the instructional material the readability was found to be 5.5. Since the study was conducted with 5th and 6th graders during the last month of the school year (grade equivalant = 5.9 for 5th graders and 6.9 for 6th graders), the researcher concluded that the variety in experiential background would be at the independent or instructional reading levels of most students.

The variety in experiential background was developed by combining the information concerning pendulums with activities based on the descriptions of the above mentioned sublevels of the Domain of Cognition. All of the combinations of the experiential background material are shown in Figure 2.

An exercise which had no content consistent with pendulums (#17 in Figure 2) was given to some of the subjects to round out the concept of "variety in experiential background" (i.e., in a typical instructional testing situation there are some who would not have had prior experience with the content being tested).

The nine types of background experiences included in Pilot Study 1 were: numbers 1, 2, 3, 4, 5, 6, 12, 16, 17. All of the types of background experiences shown in Figure 2 were included in Pilot Study 2.

PEN = Pendulum Material (information about pendulums)

r_1 = Reception: Recognition Activity

r_2 = Reception: Recollection Activity

p = Transformation: Personalization Activity

a = Transformation: Adaptation Activity

1. PEN only	2. $PENr_1$	3. $PENr_2$	4. PENp
5. PENa	6. $PENr_1r_2$	7. $PENr_1p$	8. $PENr_1a$
9. $PENr_2p$	10. $PENr_2a$	11. PENpa	12. $PENr_1r_2p$
13. $PENr_1r_2a$	14. $PENr_1pa$	15. $PENr_2pa$	16. $PENr_1r_2pa$
17. Wind Material			

Figure 2 Variety in Experiential Background Material

Directions were contained with the experiential background materials given to each subject. Materials were passed out to subjects who were then told to follow the directions as they came to them (see Appendix for samples of experiential background material used in both pilot studies).

Instrumentation

The instruments that were used to measure the dependent variables were the immediate posttest and the delayed posttest. These two instruments consisted of items as described below.

The immediate posttest contained items collecting data on four types of behavior expected to result from instruction at the end of the lesson where new information was presented to learners. These four types of behavior corresponded to four sublevels within levels two and three of the Domain of Cognition. These four types of behaviors were:

> Reception: Recognition behavior or items which required the subjects to determine whether or not information was similar to or different from information presented earlier in the same lesson. The immediate posttest contained 5 multiple choice items requiring this type of behavior in Pilot Study 1 and 4 multiple choice items requiring this type of behavior in Pilot Study 2.
>
> Reception: Recollection behavior or items which required the subjects to remember information in verbatim or near verbatim form as it was given in the same class period. The immediate posttest contained four short answer items requiring this type of behavior.
>
> Transformation: Personalization behavior or items which required the subjects to state recently received information in their own words without changing the meaning or intent of the original information. The immediate posttest contained four paraphrasing items requiring this type of behavior.
>
> Transformation Adaptation behavior or items which required the subjects to apply recently received practical information. The immediate posttest contained four application items requiring this type of behavior.

The delayed posttest contained items collecting data on four types of behavior expected to result from instruction given 23 or more hours prior to the time the behavior is to be demonstrated. These four types of behavior corresponded to four sublevels within levels four, five and six of the Domain of Cognition. These four types of behavior were:

> Retention: Recognition behavior or items which required the subjects to determine whether or not information was similar to or different from information presented 23 or more hours earlier. The delayed posttest contained 5 multiple choice items requiring this type behavior in Pilot Study 1 and four multiple choice items requiring this type of behavior in Pilot Study 2.

Retention: Recollection behavior or items which required the subjects to remember information in verbatim or near verbatim form as it was given 23 or more hours earlier. the delayed posttest contained four fill-in-the-blank items requiring this type of behavior.

Cueplication: Replication behavior or items which required the subjects to apply practical information in much the same way as it was applied or learned in the previous lesson with the presence of an external cue. The delayed posttest contained four items requiring this type of behavior.

Transfersion: Replication behavior or items which required the subjects to apply recently received information in much the same way as it was applied or learned in the previous lesson without the aid of external cues. The delayed posttest contained four application items requiring this type of behavior.

The content validity for the immediate posttest and the delayed posttest was established through consultation with the author of the model under investigation, Robert J. Stahl. Test items were developed based upon information included in the handout on pendulums. These items were consistent with the types of behavioral outcomes typically expected from instruction and were also consistent with appropriate levels within the Domain of Cognition.

The researcher administered the immediate posttest after the subjects had worked on the instructional activities. The delayed posttest was administered the next day. The subjects responded to the questions directly on the test forms. For the immediate posttest subjects were required to circle the correct answers to the Reception: Recognition items and write short answers to the Reception: Recollection items. For the Transformation: Personalization items and Transformation: Adaptation items a large enough space was included for the subjects to write paraphrased definitions or rules as well as solutions, explanations or reasons for their answers. For the delayed posttest, subjects

were required to circle the correct answers to the Retention: Recognition items, and write short answers to the Retention: Recollection items. For the Cueplication: Replication items and Transfersion: Replication items a large enough space was included for the subjects to write paraphrased definitions or rules as well as solutions, explanations or reasons for their answers. In order to insure anonymity, each subject was assigned a coding number, after which names were cut off the background material and both posttests.

Data Collection, Reduction and Analysis

Responses by the subjects to items on both the immediate posttest and the delayed posttest were made directly on the instruments. Item responses from both posttests were then transferred to IBM coding sheets by the researcher.

The computer analysis helped to determine the mean performance for each subtest of each instrument as well the the standard deviation for each subtest. Kuder-Richardson(20) Reliability Coefficients for preselected subsets of each instrument and item difficulties were computed.

Results

The results of Pilot Study 1 are presented in this section. The Research Questions investigated were:

> Research Question 1: Are the instructional activities which were developed to provide a variety in experiential background clearly understood by subjects who would use them?
>
> Research Question 2: Are the immediate posttest and the delayed posttests clearly understood by subjects who would take them?

Research Question 3: Is the internal consistency of the immediate posttest and the delayed posttest sufficiently high to warrant their use on a larger scale?

Research Question 4: Is the mean outcome performance on the subsections of each of the posttests in descending order?

Statistical procedures utilized were: the K-R(20) procedure for determining internal reliability; correlational analysis which helped determine subsection intercorrelations; item difficulties were also computed. An item was considered to be a response to a separate question on either instrument. The subsections for the immediate posttest were: Recognition (items 1-5), Recollection (items 6-9), Personalization (items 10-13), Adaptation (items 14-17 with item #16 coded as 3 separate responses; as this was the case, the computer analysis showed the total Adaptation section as items 14-19). The Adaptation subsection on the Immediate Posttest was further divided into subsections as follows:

Adaptation A = items 14, 15

Adaptation B = items 16, 18

Adaptation C = items 17, 19

Adaptation D = items 14, 15, 16, 18

Adaptation E = items 14, 15, 17, 19

Adaptation F = items 14-19

On the delayed posttest the subsections' names were the same as the variables named on the Immediate Posttest with the items classified into each category as follows: Recognition (items 1-5), Recollection (items 6-9), Personalization (items 10-13), Adaptation (items 14-17 with item numbers 14, 15 and 17 each coded as three separate responses; as this was the case the computer analysis showed the total Adaptation section

as items 14-23). The Adaptation subsection on the delayed posttest was further divided into subsections as follows:

Adaptation A = items 14, 17, 21

Adaptation B = items 15, 18, 20, 22

Adaptation C = items 16, 19, 23

Adaptation D = items 15, 18, 20, 21, 22

Adaptation E = items 15, 16, 18, 19, 20, 21, 22, 23

Adaptation F = items 14-23

Findings

The reliability coefficients for the subsections on the immediate and delayed posttests for Pilot Study 1 are shown in Table 1.

In Table 2, subjects' performance ($\bar{X}$) on each subsection is shown along with the standard deviation (σ) and the sum of the number of correct responses for that particular subsection (Σ).

Table 3 depicts the correlations of the nine subsections of the immediate and delayed posttests for Pilot Study 1.

In Pilot Study 1, both the immediate and delayed posttests had Personalization and Adaptation sections, and both were given on the day subjects experienced the experiential background material. Hence both posttests' correlation coefficients appeared together in Table 3.

Using the results of Pilot Study 1 (i.e., the computer analysis and perusal of the nature of the written responses to the items on both instruments), Pilot Study 2 was conducted to further refine both instruments. Major changes included: (1) eliminating one recognition questions from each instrument; (2) rewording the application items on the delayed posttest in order to have four questions pertaining specifically to Cueplication: Replication and four questions pertaining specifically to

Table 1 Kuder-Richardson (20) Reliability Coefficients for Subsections of Immediate and Delayed Posttests of Pilot Study 1

Subsection	Immediate	Delayed
Recognition	.50	.5[illegible]
Recollection	.72	.59
Personalization	.85	.69
Adaptation A	.70	.66
Adaptation B	.94	.53
Adaptation C	.55	.30
Adaptation D	.85	.53
Adaptation E	.80	.71
Adaptation F	.90	.82
TOTAL INSTRUMENT	.91	.88

Transfersion: Replication; (3) placing each section of both posttests on separate sheets and varying the order of the subsections as they appeared in each test; therefore, instead of just one order of the subsections for all respondents, there were twenty-four possible orders of subsections; (4) including directions at the top of each subsection of the instruments which instructed respondents to "answer all questions in order as you come to them" (the rationale for numbers 3 and 4 was to eliminate order of subsections of the instruments as a possible determinant in respect to performance; (5) "balancing" the application

sections of both posttests with a larger variety of questions encompassing all of the rules for pendulums which were introduced in the pendulum material.

Table 2 Subsection Breakdown by Mean, Standard Deviation and Number of Correct Responses for Immediate and Delayed Posttests (Pilot Study 1)

	Immediate Posttest			Delayed Posttest		
	$\bar{X}$	σ	Σ	$\bar{X}$	σ	Σ
Recognition	3.83	1.16	253.00	3.61	1.32	224.00
Recollection	1.85	1.44	122.00	2.10	1.20	130.00
Personalization	1.39	1.60	92.00	1.48	1.40	92.00
Adaptation A	.47	.75	31.00	1.10	1.05	68.00
Adaptation B	.50	.85	33.00	.89	1.04	55.00
Adaptation C	.38	.65	25.00	.48	.70	30.00
Adaptation D	.97	1.44	64.00	1.02	1.15	63.00
Adaptation E	.84	1.29	56.00	1.50	1.74	93.00
Adaptation F	1.35	2.03	89.00	2.47	2.53	153.00

In addition to the above mentioned changes in the instruments, changes in the background material were also made. The major change was in the number of different sublevel combinations that were provided. These sublevels were Recognition, Recollection, Personalization and Adaptation. Instead of just the nine different combinations being provided to respondents (as was the case in Pilot Study 1), seventeen

Table 3 Correlations of the Subsections of Immediate and Delayed Posttests for Pilot Study 1
(Note: top coefficient is Immediate Posttest and bottom coefficient is Delayed Posttest)

	Recoll.	Person.	Adap. A	Adap. B	Adap. C	Adap. D	Adap. E	Adap. F
Recog.	.50	.55	.43	.43	.40	.43	.47	.46
	.43	.44	.55	.54	.40	.55	.53	.56
Recoll.		.69	.52	.59	.60	.62	.61	.63
		.57	.58	.40	.36	.47	.46	.50
Person.			.68	.49	.58	.64	.69	.64
			.65	.57	.48	.62	.60	.63
Adap. A				.62	.70	.89	.93	.85
				.74	.63	.81	.79	.89
Adap. B					.88	.91	.80	.93
					.82	.96	.96	.95
Adap. C						.89	.91	.94
						.77	.91	.87
Adap. D							.96	.99
							.97	.94
Adap. E								.97
								.97

different varieties were given. This was done in order to insure as wide a variety as possible given the four sublevels of the Domain of Cognition that were being worked with. With this change, and using these four sublevels, as broad an experiential background condition as possible was established in Pilot Study 2.

Administration of Pilot Study 2 was done solely by the researcher in order to insure uniformity of presentation and help eliminate differences in presentation (i.e., different teachers presenting the materials in different ways) as a possible intervening variable.

The results of Pilot Study 2 are presented next. The same research questions as those posed in Pilot Study 1 were used. Incorporating the revisions from Pilot Study 1, the following subsections of each of the instruments were considered in the data analysis.

Immediate Posttest

Recognition (total)	items 1-4
Recognition (of practical information)	items 1-3
Recognition (of inert information)	item 4
Recollection (total)	items 5-8
Personalization (total)	items 9-12
Personalization (rules)	items 9-11
Personalization (definitions)	item 12
Adaptation (total)	items 13-19
Adaptation (answers)	items 13, 15, 17, 19
Adaptation (explanations)	items 14, 16, 18
Adaptation (both answers and explanations)	items 14-15, 16-17, 18-19
TOTAL TEST	items 1-19

On the Delayed Posttest, the subsections considered for data analysis were as follows:

Recognition	items 1-4
Recognition (practical information)	item 2
Recognition (inert information)	items 1, 3, 4
Recollection (total)	items 5-8
Personalization (total)	items 9-12
Personalization (rules)	item 12
Personalization (definitions)	items 9-11
Cueplication (total)	items 13-19
Cueplication (answers)	items 13, 15, 16, 18
Cueplication (explanations)	items 14, 17, 19
Transfersion (total)	items 20-27
Transfersion (answers)	items 20, 22, 24, 26
Transfersion (explanations)	items 21, 23, 25, 27
TOTAL TEST	items 1-27

The computer analysis produced different readouts for Pilot Study 2 for the the immediate and delayed posttest results as compared to Pilot Study 1. The K-R (20) reliabilities were computed only on the the total tests. Therefore, only Total Test reliabilities are reported here. The Immediate Posttest K-R(20) was .94 and the Delayed Posttest K-R(20) was .96.

Subjects' performances (X) on the subsections along with the standard deviation (σ) and the total number of correct responses for each subsection (Σ) are shown in Table 4 for both posttests.

Table 4 Subsection Breakdown by Mean, Standard Deviation and Number of Correct Responses for Immediate and Delayed Posttests (Pilot Study 2)

Subsection	Immediate Posttest			Delayed Posttest		
	$\bar{X}$	σ	Σ	$\bar{X}$	σ	Σ
Recognition (total)	2.91	1.08	131.00	2.58	1.28	111.00
(practical)	2.09	.90	94.00	.58	.50	25.00
(inert)	.82	.39	37.00	2.00	1.09	86.00
Recollection (total)	1.04	1.27	47.00	1.81	1.33	78.00
Personalization (total)	1.53	1.52	69.00	.93	1.03	40.00
(rules)	1.04	1.21	47.00	.28	.45	12.00
(definitions)	.49	.51	22.00	.65	.78	28.00
Adaptation (total)	2.51	2.47	113.00	-	-	-
(answers)	1.38	1.27	62.00	-	-	-
(explanations)	1.13	1.29	51.00	-	-	-
Cueplication (total)	-	-	-	2.30	2.46	99.00
(answers)	-	-	-	1.58	1.52	68.00
(explanations)	-	-	-	1.07	1.42	46.00
Transfersion (total)	-	-	-	2.67	2.50	115.00
(answers)	-	-	-	1.60	1.37	69.00
(explanations)	-	-	-	1.07	1.24	46.00

Tables 5 and 6 depict the correlations of the different subsections of the Immediate Posttest and Delayed Posttests for Pilot Study 2 respectively.

Table 5 Correlations of the Subsections of the Immediate Posttest for Pilot Study 2

	Recog. (prac)	Recog. (inert)	Recoll. (total)	Person. (total)	Person. (rules)	Person. (defin)	Adap. (total)	Adap. (ans)	Adap. (exn)	TOTAL TEST
Recognition (total)	.95	.62	.58	.53	.52	.40	.57	.53	.57	.72
(practical)		.34	.54	.48	.48	.33	.56	.50	.57	.67
(inert)			.40	.37	.34	.34	.30	.31	.27	.45
Recollection (total)				.48	.49	.33	.47	.43	.47	.60
Personalization (total)					.79	.72	.72	.60	.79	.83
(rules)						.62	.67	.55	.73	.80
(definitions)							.65	.54	.70	.58
Adaptation (total)								.96	.96	.92
(answers)									.85	.86
(explanations)										.91

Table 6 Correlations of the Subsections of the Delayed Posttest for Pilot Study 2

	Rec (pr)	Rec (in)	Recl (tot)	Per (tot)	Per (r)	Per (dn)	Cue. (tot)	Cue. (sol)	Cue. (exp)	Tran. (tot)	Tran. (sol)	Tran. (exp)	TOTAL TEST
Recog.(total)	.54	.92	.61	.36	.21	.35	.52	.56	.45	.46	.45	.42	.70
(practical)		.17	.35	.31	.21	.29	.55	.58	.12	.38	.31	.43	.54
(inert)			.56	.27	.14	.28	.35	.39	.32	.36	.38	.30	.57
Recollection (total)				.56	.44	.48	.57	.63	.45	.58	.67	.44	.80
Personalization (total)					.70	.91	.31	.39	.26	.48	.54	.38	.60
(rules)						.35	.31	.38	.19	.33	.37	.26	.46
(definitions)							.23	.30	.24	.44	.49	.34	.53
Cueplication (total)								.97	.95	.74	.69	.73	.87
(solutions)									.85	.68	.67	.64	.87
(explanations)										.80	.71	.82	.83
Transfersion (total)											.96	.96	.89
(solutions)												.85	.88
(explanations)													.82

Summary of the Results

As part of this project, two pilot studies were conducted each of which provided the researcher with information concerning instructional activities (variety in experiential background) and two posttests (i.e., Immediate Posttest and Delayed Posttest) which were in turn used for a larger investigation regarding the Domain of Cognition, a taxonomy of instructional outcomes.

In Pilot Study 1, the major findings were:

A. In general, there was moderately high to high subsection internal consistency (reliability) for both posttests.

B. Both posttests had high total test internal consistency (reliability = .91 for Immediate Posttest and .88 for Delayed Posttest).

C. The mean score performance on the Immediate Posttest with the subsections of Recognition, Recollection, Personalization and Adaptation (any of the divisions thereof) was in a descending order). The mean score performance on the Delayed Posttest was in descending order regarding the same subsections except that Adaptation E and Adaptation F had mean score outcome performances greater than Personalization.

D. The instructional activities (variety in experiential background) were clear to subjects in respect to understanding what was to be done, what types of responses were to be given (i.e., circle to correct responses for recognition, provide a short-answer response for recollection, stating a rule or definition in their own words for personalization, and stating solutions and/or explanations for adaptation.

E. The immediate and delayed posttests were (a) clear to subjects in respect to understanding what was to be done and what types of responses were to be given (i.e., circle the correct response for recognition, provide a short-answer response for recollection, stating a rule or definition in their own words for personalization, and stating solutions and/or explanations for adaptation), with the exception of #17 on the Immediate Posttest where responses did not coincide with the intent of the question; (b) had three items which were relatively easy (see "discussion" section following).

In Pilot Study 2, the major findings were:

A. The internal consistency (reliability) for both posttests was high (reliability = .94 for the Immediate Posttest and .96 for the Delayed Posttest).

B. The mean score performance on the Immediate Posttest was not in a descending order. The outcome order was: Recognition - Personalization - Adaptation - Recollection. The mean score performance on the Delayed Posttest was not in a descending order. The outcome order was: Recognition - Recollection - Transfersion (answers) - Cueplication (answers). (Note: the difference between the Transfersion and Cueplication mean subsection performance was .02).

C. The instructional activities (variety in experiential background) were clear to subjects in respect to understanding what was to be done, what types of responses were to be given (i.e., circle the correct responses for recognition, provide a short-answer response for recollection, stating a rule or definition in their own words for personalization, and stating solutions and/or explanations for adaptation).

D. The immediate and delayed posttests were (a) clear to subjects in respect to understanding what was to be be done and what types of responses were to be given (i.e., circle the correct response for recognition, provide a short-answer response for recollection, stating a rule or definition for personalization, and stating solutions and/or explanations for adaptation).

Conclusions and Discussion

Based upon the results obtained via Pilot Study 1 and Pilot Study 2 and via consultation with Robert J. Stahl, the decision was made to conduct the larger study (dissertation for Ed.D.).

Pilot Study 1 provided the researcher with preliminary information concerning the feasibility of the experiential background material and secondly, provided crucial feedback concerning the applicability of the Immediate and Delayed Posttests. Since the nature of the responses to the experiential background material showed that subjects understood what they were supposed to do, and secondly the items within the

experiential background material were developed under guidance from Robert J. Stahl, no changes were made in their content.

The posttests underwent some revisions from Pilot Study 1 to Pilot Study 2. Though the computer analysis showed that some items were relatively easy and some were relatively difficult on each posttest, the primary considerations for eliminating any item were (a) whether or not the item was clearly understood by subjects and (b) whether or not it sampled the content deemed important and appropriate for this study. According to Gronlund (1982), no item on a criterion-referenced test should be eliminated simple because most students answered it correctly or because it might be answered incorrectly by most students(p. 31). What was sought in both instruments was a set of questions which matched the sublevels of the Domain of Cognition as those questions pertained to the content under consideration (i.e., pendulums). Changes that were made from Pilot Study 1 to Pilot Study 2 were based upon efforts to obtain as accurate an indication of the type of behavior described in the Domain of Cognition as possible.

Test items were constructed based upon close consultation with Robert J. Stahl and were considered as being appropriately worded in relationship to the sublevel each represented, as well as amply sampling the content under consideration. There were only four items written for each of the four sublevels under consideration in each posttest. The instruments were deliberately this compact because of three factors: (1) With 5th and 6th graders, the amount of time students this age can concentrate on one activity is limited. Because the reading of the information and working on the variety in experiential background material took approximately 30-40 minutes, and the immediate posttest

was to be given afterwards, the researcher had to plan for and prepare an instrument which wouldn't take over 15-20 minutes to complete. (2) Scheduling constraints were also taken into consideration when determining the length of the instrument. For the main study, scheduling fourteen classes within the morning hours around teachers' schedules, resource schedules, restroom breaks, etc. was primary when considering how much could be done. (3) The length of the instruments was also tied to the nature of the content utilized in the research. The amount of information concerning pendulums is not particularly abundant. Though one could justifiably query as to why something of a broader nature wasn't chosen, as equally valid response would be to assert that a lesson couldn't be too broad or general because they wouldn't "get anything out of it", especially with just one contact with it.

The researcher was not concerned as much with assumptions underlying norm-referenced testing as with those related to criterion-referenced testing. The model under investigation describes a sequence of behavioral outcomes of instruction where mastery of lower levels will help learners "transfer" to higher levels (but will not necessarily guarantee higher level mastery). The major focus was on whether or not students can show mastery of prespecified learning outcomes (i.e., whether or not predetermined behaviors can be demonstrated) rather than on how a particular student compared to other students.

Because of the above mentioned factors concerning criterion-referenced testing considerations as well as those mentioned concerning the compactness of both instruments, the decision was made to conduct the main study using the experiential background material as utilized in

both pilot studies and the revised immediate and delayed posttests as they were used in Pilot Study 2.

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APPENDIXES

Appendix A - Immediate Posttest (first Pilot Study)

Old
IP

Questions for Review

TO THE BEST OF YOUR ABILITY, CIRCLE THE CORRECT ANSWER TO THE FOLLOWING QUESTIONS.

1. Which of the following statements gives the meaning of a pendulum?

   A. Any object which can move freely around in circles.

   B. Any object which can move freely back and forth.

   C. Any object hung so that it can move freely back and forth.

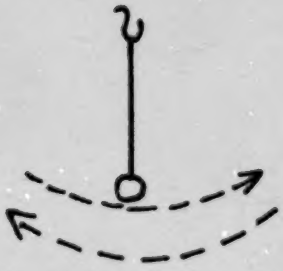
   D. Any object which can move freely up and down.

2. Which picture shows a complete swing of a pendulum?

A.

B.

C.



D.

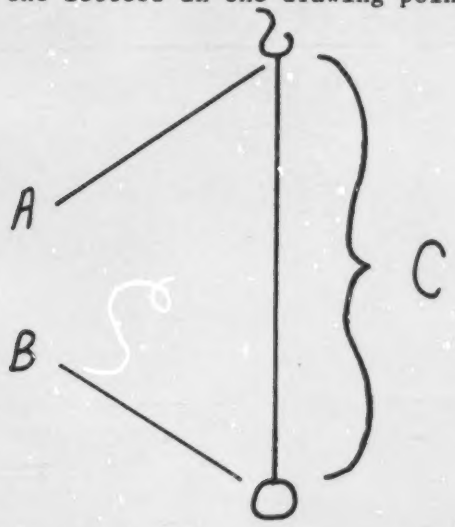
3. Which of the following will cause a pendulum to make a complete swing in more time?

   A. A pendulum that is longer

   B. A lighter weight

   C. Pulling the weight back far

4. Which of the letters in the drawing points to the bob.



5. What was the name of the first scientist to study pendulums?

   A. Edgar Allen Poe

   B. Miguel Vazquez

   C. Galileo

6. You read about different examples of pendulums. What was one example of a pendulum mentioned? _____

7. What is the name scientists give to ways of describing what will take place every time an event occurs? _____

8. What is the name of the very difficult stunt which only one person has been able to do on the trapeze? _____

9. What is the name given to the part of the pendulum where it is attached to its support? _____

10. In your own words, what is the rule for pendulum swings and the length of the pendulum's arm?

11. In your own words, what is the rule for pendulum swings and its distance from the earth?

12. In your own words, what is the rule for pendulum swings and how far back the weight is pulled?

13. In your own words, what is an <u>arm</u> of a pendulum?

14. Suppose that you want to see how long it takes for a friend to run to a wall and back. All that you have to time your friend with is a homemade pendulum that you've made. You know that your homemade pendulum takes one second to make a complete swing. Explain how you could tell how long it takes for your friend to run to the wall and back.

15. A race involves swinging across a river on a rope. Based on what is known about pendulums, what would you do to swing across the river in the fastest way possible?

16. A race involves swinging across a river on a rope. One person thought he could swing across faster that the others by stepping back as far as he could before he swung across. Would he swing across in less time than the others? Please give the reason for your answer.

17. A grandfather clock is losing time (is running slow). Based upon what is known about pendulums, what should be done to the clock's pendulum to make it run faster?

Appendix B - Delayed Posttest (first Pilot Study)

More Questions for Review

TO THE BEST OF YOUR ABILITY, CIRCLE THE CORRECT ANSWER TO THE FOLLOWING QUESTIONS.

1. Which is an example of a pendulum?

   A. A moving swing

   B. A merry-go-round

   C. A teeter-totter

   D. A twirling jump rope

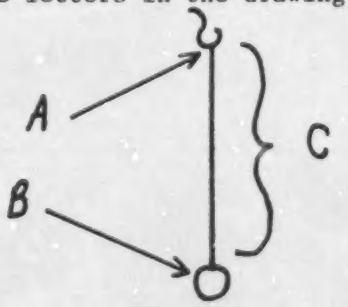
2. Which of the following will cause a pendulum to make a complete swing in less time?

   A. A pendulum that is shorter

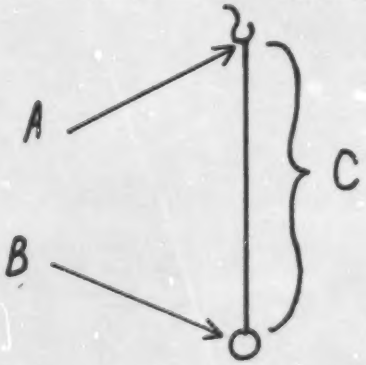
   B. A heavier weight

   C. Pulling the weight back farther

3. Which of the letters in the drawing points to the pivot.



4. Which of the letters in the drawing points to the arm.



5. What was the name of the writer who wrote The Pit and the Pendulum?

   A. Edgar Allen Poe

   B. Miguel Vazquez

   C. Galileo

   D. William Shakespeare

6. What is the name of the movie character who could be used as an example of a pendulum? _____

7. What is the name of the clocks which have pendulums inside of them?

   _____

8. What is the weight at the end of the pendulum called?

   _____

9. What do scientists call the movement of a pendulum when it goes all the way forward and then back again? _____

10. In your own words, what is a pendulum?

11. In your own words, what does the word rule mean is science?

12. In your own words, what is meant by the pivot of a pendulum?

13. When the weight on one pendulum is heavier than the weight on another, what difference will there be in the time it takes the two pendulums to swing back and forth once?

14. A mouse was placed on a swing and was pulled back 3 feet. A complete swing was timed and it took 6 seconds. Next a large dog was placed on the same swing. The swing again was pulled back 3 feet. Will a complete swing take less time, more time or the same time for the dog. Please explain your answer.

15. A race involves swinging across a river on a rope. One person thought she could swing across the river faster than all of the others by putting some rocks in her pockets (she thought that the heavier she became, the faster she could swing across). Based upon what is known about pendulums, was this person wise? Please give the reason for your answer?

16. A trapese artist made the trapeze ropes longer for his act. What will happen to the swinging of the trapeze when this is done?

17. John and his family lived at the bottom of the Grand Canyon. He owned swing set which he liked to swing on. One day he and his family moved to the top of the Grand Canyon which was about 5000 feet above the bottom. Compared to the bottom of the Grand Canyon, what will the boys notice about a complete swing at the top of the Grand Canyon. Explain your answer.

Appendix C - Immediate Posttest (second Pilot Study)

New IP

Directions: Answer the questions in order as you come to them

CIRCLE THE CORRECT ANSWER TO THE FOLLOWING QUESTIONS

Which of the following statements gives the meaning of a pendulum?

A. Any object which can move freely around in circles.

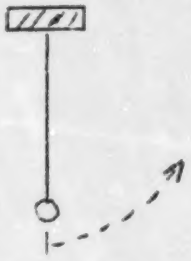
B. Any object which can move freely back and forth.

C. Any object hung so that it can move freely back and forth.

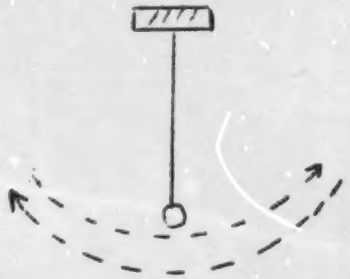
D. Any object which can move freely up and down.

Which picture shows a complete swing of a pendulum?

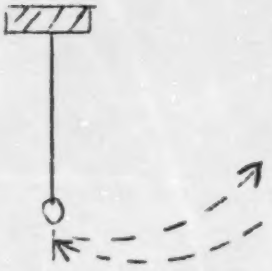
A.



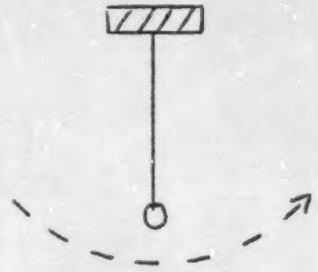
B



C.



D.



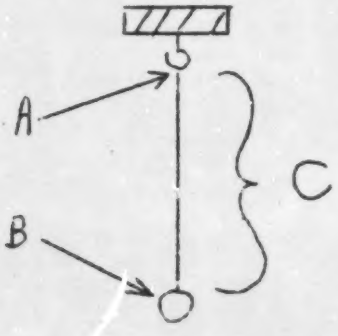
Which of the following will cause a pendulum to make a complete swing in more time?

A. A pendulum that is longer

B. A lighter weight

C. Pulling the weight back far

Which of the letters in the drawing points to the bob?



Directions: Answer all questions in order as you come to them

You read about different examples of pendulums. What was one example of a pendulum mentioned?

What is the name scientists give to ways of describing what will take place every time an event occurs?

What is the name of the very difficult stunt which only one person has been able to do on the trapeze?

What is the name given to the part of the pendulum where it is attached to its support?

Directions: Answer all questions in order as you come to them

In your own words, what is the rule for pendulums dealing with how long the pendulum is?

In your own words, what is the rule for pendulums dealing with how far it is from the earth?

In your own words, what is the rule for pendulums dealing with how far back the weight is pulled?

In your own words, what is an <u>arm</u> of a pendulum?

Directions: Answer all questions in order as you come to them

Suppose that you want to see how long it takes for a friend to run to a wall and back. All that you have to time your friend with is a homemade pendulum that you've made. You know that your homemade pendulum takes one second to make a complete swing. Explain how you could tell how long it takes for your friend to run to the wall and back.

A race involves swinging across a river on a rope. Based on what is known about pendulums, how can you change the ropes of the swing in order to swing across the river in the fastest way possible? Please explain your answer.

A race involves swinging across a river on a rope. One person thought he could swing across faster than the others by stepping back as far as he could before he swung across. Based on the rules for pendulums, would he swing across in less time than the others? Please explain your answer.

Thin Kim and fat Matt were always arguing about who was better. Thin Kim said, OK, let's have a contest." She pointed to a bag swing and said, "Whoever can swing back and forth once, in less time, is the winner." (She thought she'd win because she wasn't as heavy as Matt). From what you know about pendulums, will Kim win? Please explain your answer.

Appendix D - Delayed Posttest (second Pilot Study)

New

DP

Directions: Answer the questions in order as you come to them

TO THE BEST OF YOUR ABILITY, CIRCLE THE CORRECT ANSWER TO THE FOLLOWING QUESTIONS.

→ Which is an example of a pendulum?

A. A moving swing

B. A merry-go-round

C. A teeter-totter

D. A twirling jump rope

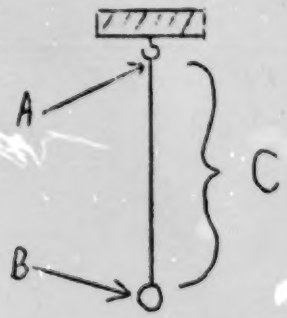
→ Which of the following will cause a pendulum to take a complete swing in less time?

A. A pendulum that is shorter

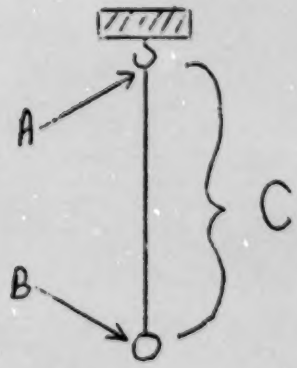
B. A heavier weight

C. Pulling the weight back farther

→ Which of the letters in the drawing points to the pivot.



→ Which of the letters in the drawing points to the arm.



Directions: Answer all questions in order as you come to them

➔What is the name of the movie character who could be used as as example of a pendulum?

_____

➔What is the name of the clocks which have pendulums inside of them?

_____

➔What is the weight at the end of the pendulum called?

_____

➔What do scientists call the movement of a pendulum when it goes all the way forward and then back again?

_____

➔In your own words, what is a pendulum?

➔In your own words, what does the word rule mean in science?

➔In your own words, what is meant by the pivot of a pendulum?

➔When the weight on one pendulum is heavier than the weight on another, what difference will there be in the time it takes the two pendulums to swing back and forth once?

Direction: Answer the questions in order as you come to them

→ A race involves swinging across a river on a rope. One person thought she could swing across the river faster than all of the others by putting some rocks in her pockets (she thought that the heavier she became, the faster she could swing across). Based upon the rule for pendulums dealing with how heavy the weight is, was this person wise? Please give the reason for your answer?

→ A trapeze artist made the trapeze ropes longer for his act. Based upon the rule for pendulums dealing with how long the arm is, will a complete swing take less time, more time or the same time as before?

→ In a Tarzan movie, Tarzan was shown swinging from one tree to another. Jane told Tarzan that he could swing to each tree in less time if he would just step back farther before he swung. Based upon the rule for pendulums dealing with how far back the weight is pulled, was Jane right? Please explain your answer.

→ The Air Force built a giant space station so large that a whole city could fit inside! Pretend that you are in this giant space station and that you could play on a swing set built just for you. Based on the rule for pendulums dealing with how far away from the earth they are, what will you notice about a complete swing way up in space compared to the same swing set on Earth? Please explain your answer.

Direction: Answer the questions in order as you come to them

→ A mouse was place on a swing and was pulled back 3 feet. A complete swing was timed and it took 6 seconds. Next a large dog was placed on the same swing. The swing again was pulled back 3 feet. Will a complete swing take less time, more time or the same time for the dog? Please explain your answer.

→ John and his family lived at the bottom of the Grand Canyon. He owned a swing set which he liked to swing on. One day he and his family moved to the top of the Grand Canyon which was about 5000 feet above the bottom. Compared to the bottom of the Grand Canyon, what will the boys notice about a complete swing at the top of the Grand Canyon? Please explain your answer.

→ Each of 4 people in a contest were told that if they could make their pendulum swing all the way forward and back again in the least amount of time, then they would win $1000! Jim had an idea. He was going to pull his pendulum all the way back as far as possible so it would swing faster. Would his pendulum make a complete swing in less time? Please explain your answer.

→ A grandfather clock is losing time (is running slow). Besides winding the clock or pushing the pendulum, what can be done to the clock's pendulum to make the clock run faster? Please explain your answer.

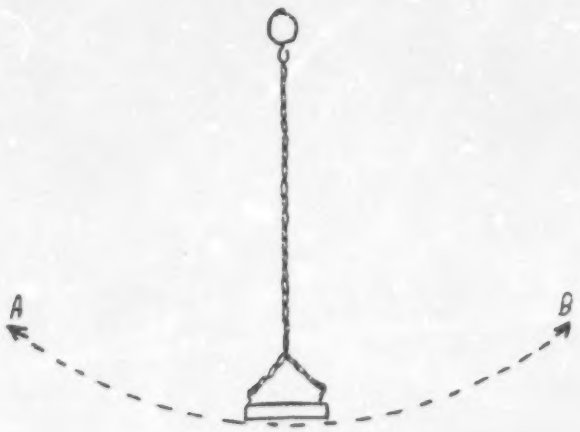
Appendix E - Pendulum Material

PENDULUMS

When was the last time you sat on a swing? How high did you swing? Swings have been enjoyed by people of all ages. The swinging motion of a swing is both fun and interesting.

A swing works like a pendulum. A pendulum is an object hung so it can move freely back and forth. A pendulum can be made by tying a weight to a string. The weight is usually small and heavy such as a stone. The string should be hung so that the weight can freely swing back and forth.

The drawing below of a swing will help explain the motion of a pendulum.



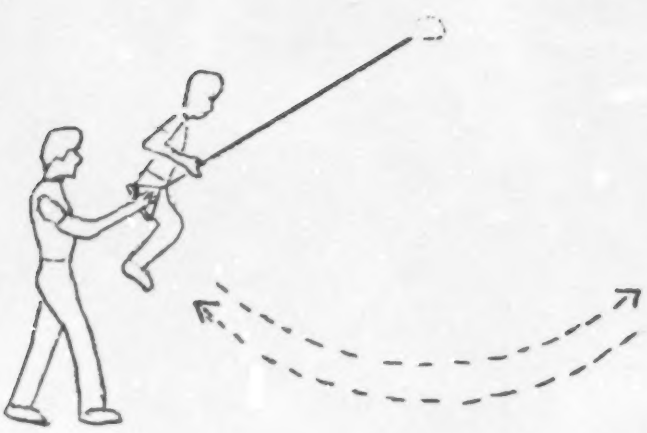
Like a swing on a playground, all pendulums have some things in common. The place where the swing connects to the support is called a pivot. From the pivot to the seat of the swing is called the arm. One complete swing would be when the person swings from A to B and then back to A again.

Many people have studied the pendulum. The first to study the pendulum was probably Galileo. Galileo was a scientist who lived in Italy in the 1500's. Galileo thought about many of the things he saw. Once he saw a hanging lamp swinging back and forth. He timed the swing of the lamp. Galileo discovered that the time it takes to complete a wide swing and a small swing was the same. Other discoveries about pendulums were made by him and by other scientists.

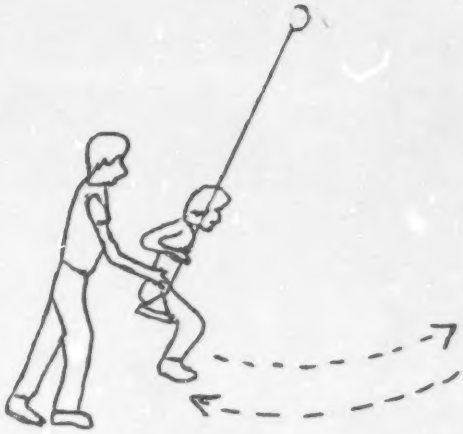
Scientists sometimes call these discoveries rules. Rules are ways of describing what will take place every time an event occurs.

There are four rules you can learn about pendulums. These can be used to help you learn about swings and swinging.

> Rule 1. It doesn't matter how far back the swing is pulled. The time it takes for a complete swing will be the same when it is pulled back far as when it is pulled back a short distance.



Picture 1



Picture 2

In picture 1 above, the man has pulled his son back far. The time it takes to swing all the way forward and back again is 5 seconds. In picture 2 above, the man is pulling his son back a short distance on the same swing. The time it takes to swing all the way forward and back again will still be 5 seconds!

Rule 2. It doesn't matter how heavy the weight on the swing is. The time it takes for something heavy to swing back and forth will be the same for something which is light.

Picture 3

Picture 4

In pictures 3 and 4 above both swings have been pulled back the same distance. In picture 3 the person weighs 200 pounds but in picture 4 the person only weighs 50 pounds. The time it takes to make one complete swing is 5 seconds. One will not finish sooner than the other!

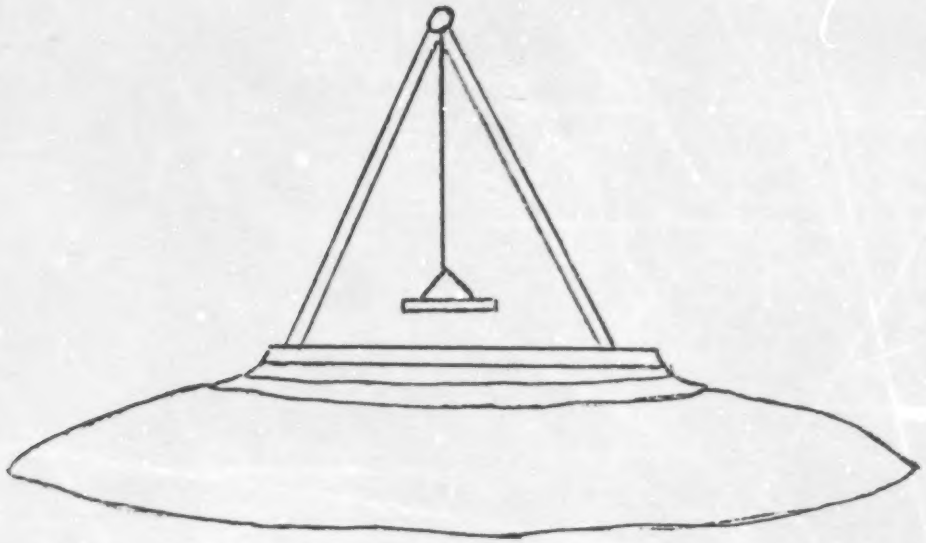
Rule 3. It does matter how long the arm of the swing is. The longer the arm, the more time it takes to make a complete swing. The shorter the arm, the less time it takes to make a complete swing.

Picture 5

Picture 6

The arm of the swing in picture 5 above is longer than the arm of the swing in picture 6. It takes more time for the swing in picture 5 to swing back and forth once than the swing in picture 6.

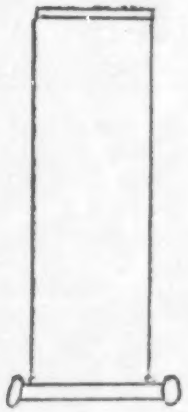
Rule 4. It does matter how far away from the earth a swing is. The farther away from the earth, the more time it takes to make a complete swing.



Picture 7

In picture 7 above there is a swing placed on top of a flying saucer. The flying saucer is 5 miles above Miami, Arizona. The time it takes to swing back and forth once will be more than if the same swing was on the ground!

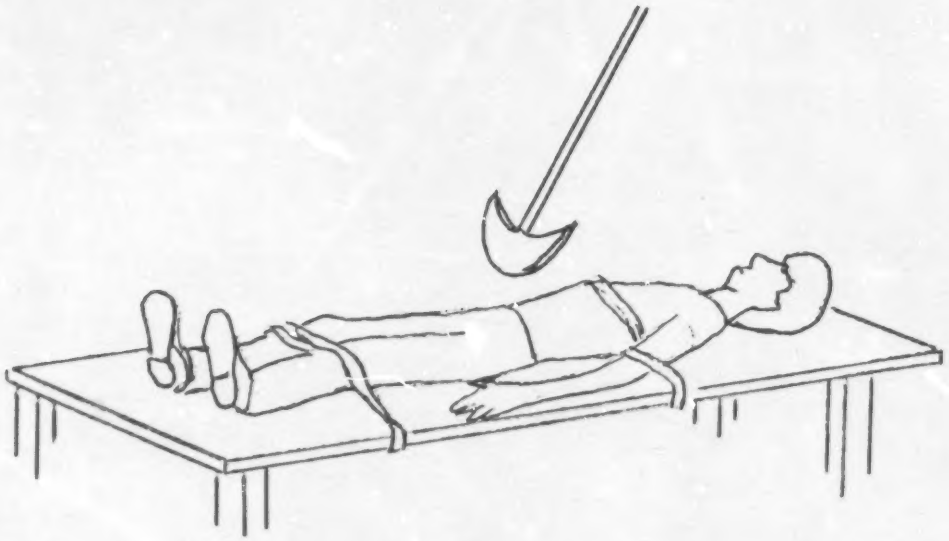
Other examples of pendulums exist besides swings. The trapeze shown below is another example of a pendulum.



Trapeze

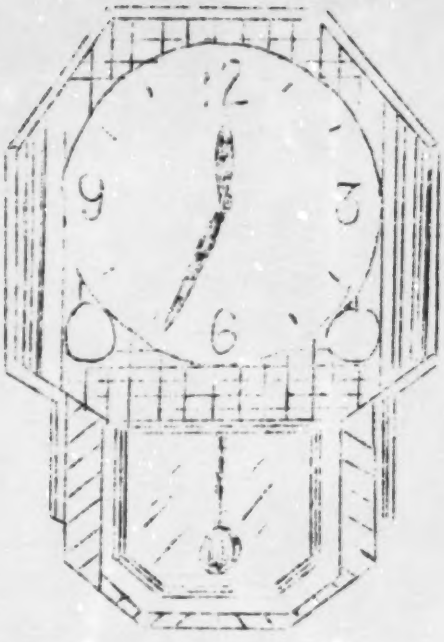
A famous group of trapeze artists now appearing in circuses in The Flying Vazquez Family from Mexico. Miguel Vazquez has become the first and only performer ever to do the quadruple-somersault! This is 4 complete flips in mid-air before reaching the catcher's hands. The catcher, hanging by his knees, swings back and forth as Miguel swings high into the air. At just the right moment, Miguel releases his trapeze, flips 4 times, and is caught safely!

Another example of a pendulum can be found in the story called The Pit and the Pendulum by Edgar Allen Poe. This story is about a man in prison who is tied to a table. Above him is a large pendulum which is slowly coming down toward him. The arm of the pendulum is metal and the bob is an axe! The story describes this man's escape from the table before the pendulum reaches him.



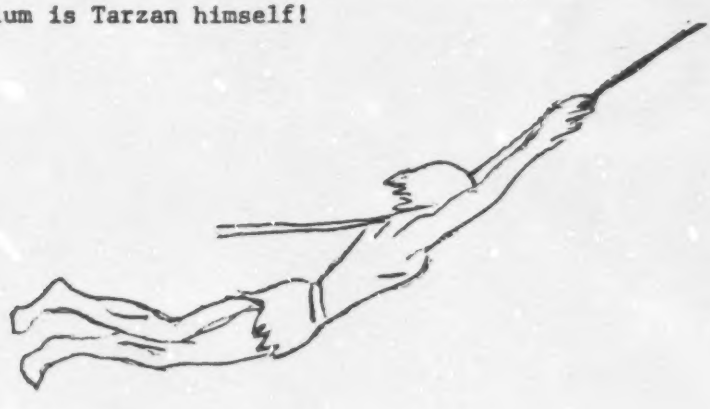
The Pit and the Pendulum

Another example of the use of pendulums is in grandfather clocks. These types of clocks have a swinging pendulum inside of them. As the pendulum swings back and forth the hands of the clock move to keep time.



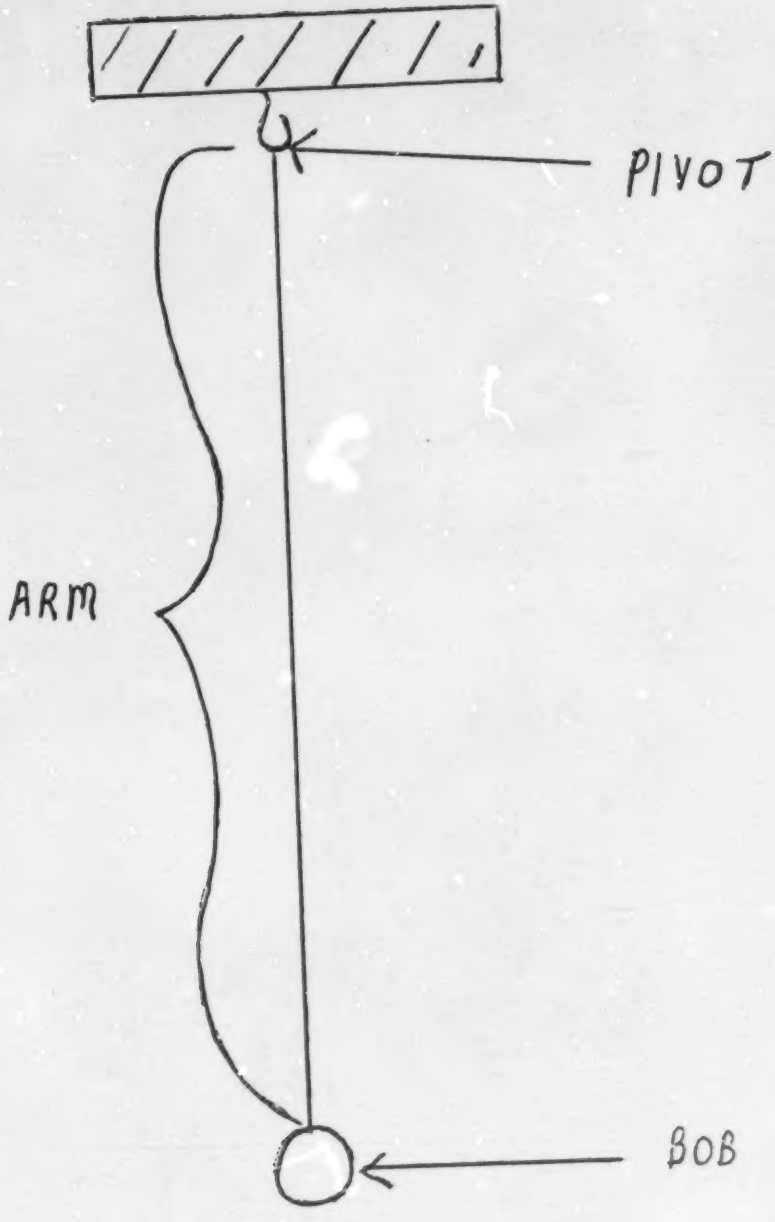
Grandfather Clock

Another example of a pendulum can be seen in the Tarzan movies. Tarzan swings on a vine from one side of a river to the other. The bob of the pendulum is Tarzan himself!



Tarzan

From all of the examples of pendulums that have been given, it can be seen that any object hung so that it can freely move back and forth can be called a pendulum. The picture on the next page shows how a pendulum may be drawn.



The Pendulum

Appendix F - Wind Material

THE WIND

Wind is moving air. Sometimes wind blows softly. At other times it is strong enough to knock down trees or lift cars.

Air moves because of differences in temperature. When air is heated it moves faster and becomes light. Air expands when it is heated. This causes the air to spread apart. Warm air rises away from the earth.

When air is cooled it contracts. Cooling causes the air to come closer together. This makes the air become heavier than warm air. Cool air sinks toward the earth.

As cool, heavy air presses down on the earth, the air pressure is high. But as warm, light air rises away from the earth, the air pressure is low.

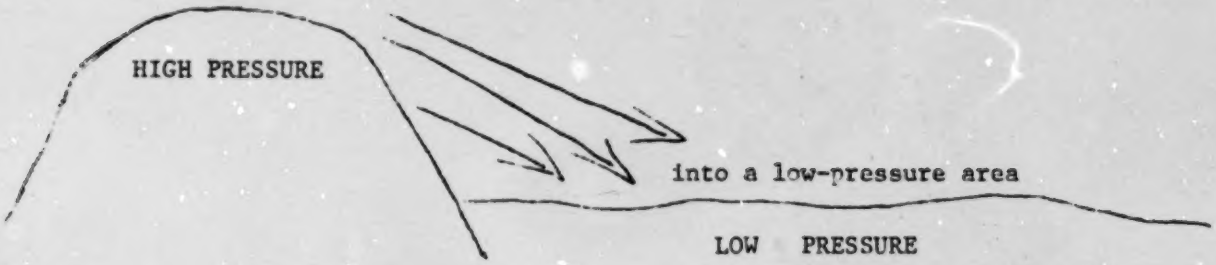
Cool air sinks, pressing downward. The air pressure is HIGH.

Warm air rises. The air pressure is LOW.

Air flows out of places where the pressure is high, to places where the pressure is low. A high-pressure area is like a hill and a low-pressure area is like a valley.

Air flows from a

high-pressure area

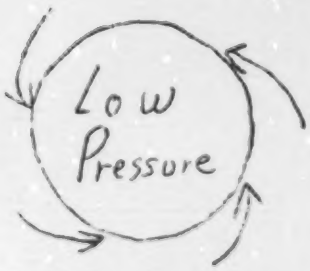


Air moving away from a high-pressure area toward a low-pressure area makes <u>wind</u>. When there is a big difference in pressure, a powerful wind is made. When there is a small difference in pressure, a gentle wind is made.

When a town is under <u>high-pressure</u> the weather is usually <u>fair</u> (nice), and the winds are not strong. But when a town is under <u>low-pressure</u>, the weather is usually <u>bad</u> and the winds are strong.

As air moves <u>out</u> of a high-pressure area it moves <u>clockwise</u> (in the same direction as the hands move on a clock).

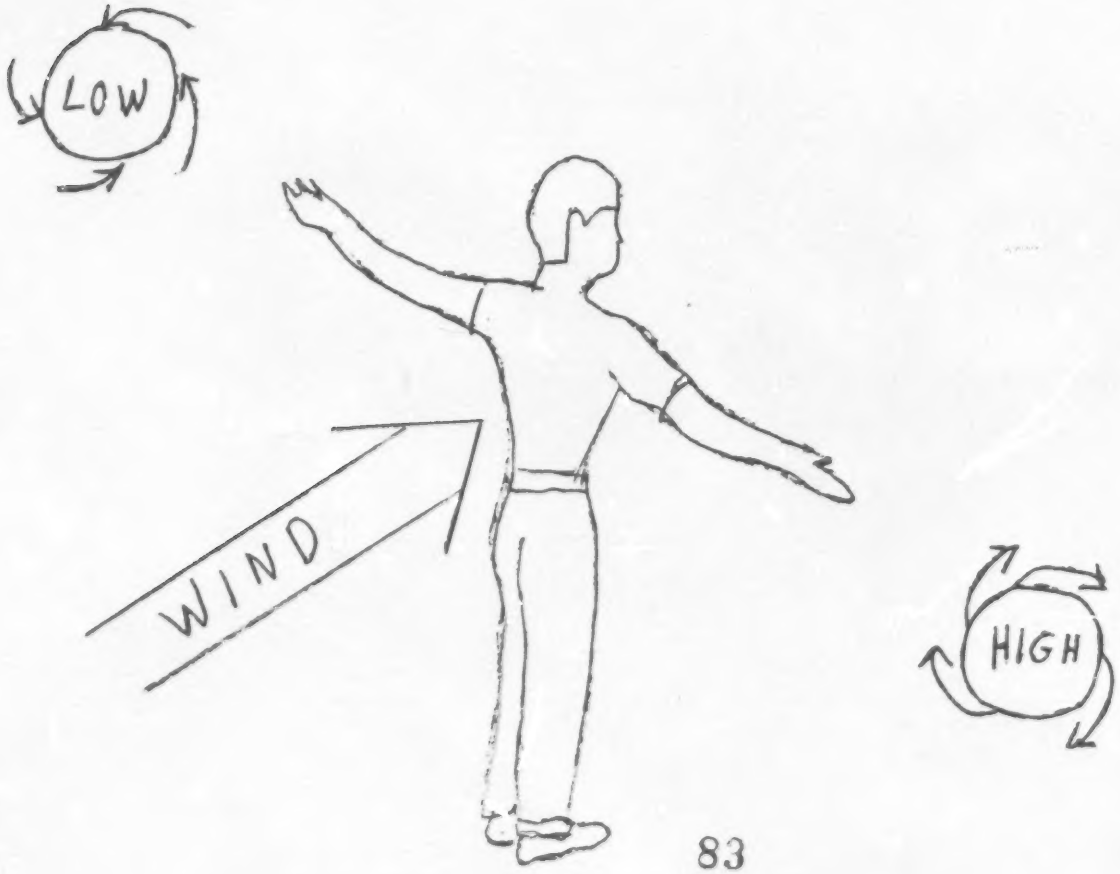
Just the opposite takes place in a low-pressure area. The air moves <u>into</u> a low-pressure area <u>counter-clockwise</u> (like a clock moving backwards).



Win's blow from a high into a low.

When high-pressures and low-pressures cause wind, you can tell where the high is and where the low is. You can use Ballot's Law to point to the direction of the high and to the direction of the low.

Ballot's Law - Turn your back to the wind. The low-pressure area will be on your left (just remember: "left" and "low" both begin with "l"). The high-pressure area will be on your right.



Appendix G - Variety in Experiential Background Material

BASED UPON WHAT YOU KNOW ABOUT PENDULUMS, CIRCLE THE CORRECT ANSWER TO THE FOLLOWING QUESTIONS.

1. Which of the following statements gives the meaning of a pendulum?

   A. Any object which can move freely around in circles.

   B. Any object which can move freely back and forth.

   C. Any object hung so that can move freely back and forth.

   D. Any object which can move freely up and down.

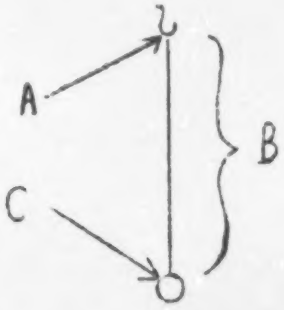
2. Which of the following will cause a pendulum to make a complete swing in more time?

   A. An arm that is longer

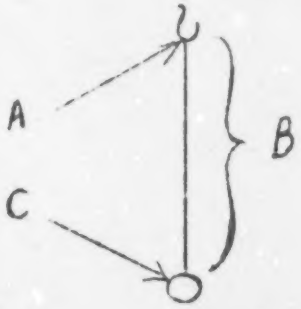
   B. A lighter weight

   C. Pulling the bob back far

3. Which of the letters in the drawing points to the pivot.



4. Which of the letters in the drawing points to the bob.



BASED UPON WHAT YOU KNOW ABOUT PENDULUMS, DO YOUR BEST TO ANSWER THE FOLLOWING QUESTIONS.

1. According to the story, what is a pendulum?

_____

_____

2. A pendulum swings as far forward as it can go and then swings back as far as it can go. What do scientists call this movement?

_____

3. Scientists have a name for ways of describing what will take place every time an event occurs. What is this name?_____

4. What is the name of the place where the pendulum is connected to its support?_____

BASED UPON WHAT YOU KNOW ABOUT PENDULUMS, DO YOUR BEST TO ANSWER THE FOLLOWING QUESTIONS.

1. In your own words, what is the rule for a pendulum's swing dealing with the length of the arm? _____

_____

_____

2. In your own words, what is the rule for a pendulum's swing dealing with how far back the bob is pulled? _____

_____

_____

3. In your own words, what is the rule for a pendulum's swing dealing with the weight of the bob? _____

_____

_____

4. In your own words, what is the rule for a pendulum's swing dealing with the distance a pendulum is from the earth? _____

_____

_____

BASED UPON WHAT YOU KNOW ABOUT PENDULUMS, ANSWER THE FOLLOWING QUESTIONS.

1. Pendulums can be made to swing faster or slower. Grandfather clocks sometimes lose time (run too slow) because their pendulums swing too slowly. Using what you know about pendulums, what should be done to their pendulums to make them run faster?

2. Some kids were swinging across a river on a rope. They decided to have a contest to see who could swing across in the least amount of time. A girl thought that if she put some heavy things in her pockets then she would win. Would she be able to swing across the river in less than others? Please explain your answer.

3. In the same contest another child thought he could win if he stepped back as far as he could before he swung across. Would he be able to swing across in less time than the others? Please explain your answer.

4. Mary and her family lived high in the mountains. Mary owned a swingset which she liked to swing on. She moved to the valley far below. Compared to the mountaintop what will Mary notice about a complete swing in the valley? Please explain your answer.